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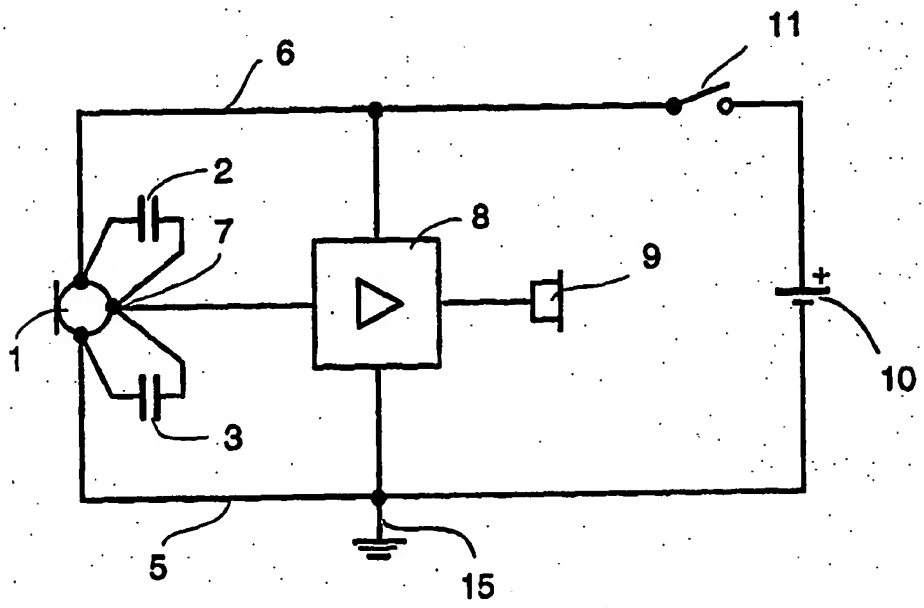

(57) Abstract

A hearing aid having an Electrete microphone (1) comprises an amplifier (8) connected to the output side of the microphone via an HF-filter device having in particular a frequency range between 900 and 1600 MHz. In order to provide a hearing aid with an effective interference suppression, an HF-filter device can be used consisting of two capacitors (2, 3) which are arranged between the signal output (7) of the microphone, the ground connection (15) and the supply connection (6).

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HF-Anti-Interference Device

The invention relates to a hearing aid having an Electrete microphone with its output connected via an HF-filter device to an amplifier, said HF-filter device being operable particularly in a frequency range between 900 - 1600 MHz.

Hearing aids of this kind are in general merely low-frequency amplifiers. In those hearing aids interference can be observed due to high-frequency (HF) cross-talk.

It is well known that in the close neighbourhood of strong amplitude-modulated broadcast transmitters such cross-talk may cause that the broad-casted radio program will become audible in the hearing aid. Obviously, the microphone and its connection wires have the effect of an antenna so that the HF-energy is demodulated at the input transistor in a grid-leak detector-like effect and becomes audible.

A simple remedy for such interference is known for a long time and is state of the art. On the circuit board, next to the connection points of the microphone, a capacitor of some hundred or thousand Picofarad (pF) will be connected which shunts off the HF-part of the microphone signal to ground and makes it inoperative. This measure works quite well even with respect to UHF-broad-casting (100 MHz-range).

Unfortunately, the HF-noise sources increase more and more in number which requires also new precautionary measures.

In the recent past, the spread of the so-called "Handies" has strongly increased, in particular those of the GSM (Global System for Mobiles) or E-net telephone. This system works in a frequency range of about 890-915 MHz (mobile unit to base station) and 935-960 MHz (base station to mobile unit).

In electromagnetic compatibility tests according to IEC 29 (sec) 281 it was found that for these frequency ranges hearing aids are particularly sensitive to HF-interference, although the dimension of the microphone including the connecting wires (approximately 25-30 mm) are much smaller than the wave length in question (approximately 300 mm).

The National Acoustic Laboratories in Sidney have already performed tests to solve this problem. As a solution it was suggested either to shield the housing by means of an internal metal layer, for example a galvanically deposited Cu/Ni-layer or a silver conducting-varnish, or to use conductive plastic, or to connect a capacitor directly at the microphone. As mentioned in the above source, the shielding method is not very practical. It is quite effective but expensive in production. Moreover, the conductive layer is often the reason for short circuits inside the hearing aid, where there is a lack of space anyway.

Further, it was found that the capacitor mentioned must have a capacity of at least about 68 pF in order to keep the interference within the required limits. However, since this capacitor is available in the 0805-size only, this method is not recommendable at all . We talk about chip capacitors without leads as they are common as surface-mounted devices (SMD) today. Yet, size 0805 is as large as 2x1.27x0.63 mm^3, which does not permit direct attachment to the microphones and, as a matter of fact, makes it nearly impossible.

In hearing aids, as mentioned above, Electrete microphones are commonly used which have a field effect transistor (FET) built-in as an impedance transformer. It seems that disturbing cross-talks are generated already in this FET which demodulates the HF-energy entering the microphone via the stranded connecting wires. This leads to the fact that the anti-interference capacitor on the circuit-board carrying the rest of the parts of the hearing aid is no longer effective and the desired interference suppression does not work.

It is an object of this invention to avoid these disadvantages and to provide a hearing aid where an effective interference suppression can be obtained in a most simple way.

According to the invention this is reached for a hearing aid having an Electrete microphone connected with its output via an HF-filter device to an amplifier which HF-filter device being operable in particular in a frequency range between about 900 and 1600 MHz. The HF-filter device which consists of two capacitors which are arranged between the signal output of the microphone, the ground connection and the power supply connection.

The invention suggests to replace the single capacitor used so far by two capacitors, having an accordingly smaller capacity and, therefore, being also smaller in size. Since these capacitors are connected very closely to the microphone terminals, no resonant circuit can develop as it would result from longer connecting wires.

In addition, it has shown that the two capacitors suggested have a better anti–interference effect than one larger single capacitor used so far.

The invention can be embodied by either connecting the capacitors between the signal output of the microphone and the ground connection or between signal output of the microphone and the power supply connection, respectively, or by connecting one side of each of the capacitors to the ground connection, while the one electrode of one capacitor is connected to the signal output of the microphone and the other electrode of the other capacitor is connected to the power supply connection.

The advantage that very small capacitors can be used is given by the utilisation of SMD-chip capacitors.

Since it is suggested to solder the capacitors directly to the solder pads of the microphone the danger of generating a resonant circuit is minimized.

A particularly space-saving arrangement is offered with the capacitors being directly connected to the microphone terminals lying flat on the microphone and being connected to their soldering pads by wires with a maximum length of 5 mm.

A particularly advantageous arrangement of the anti-interference device is reached by the integration of the two capacitors into a ceramic substrate inside the housing of the microphone.

Now, the invention is described in more details with respect to the drawings.

Fig. 1 shows a block diagram of one embodiment of a hearing aid according to the invention;

Figs. 2 and 3 show a side view and a top view of a microphone fitted with capacitors;

Figs. 4 and 5 show diagrams regarding the interference sensitivity without and with capacitors proposed by the invention; and

Fig. 6 shows a block diagram of another embodiment of a hearing aid according to the invention.

A hearing aid according to the invention comprises an Electrete microphone 1 which is connected through conductor 5 to a ground connection 15 as well as the negative side of a battery 10. There is also a conductor 6 connected via a switch 11 to the positive side of the battery 10. Both the conductors 5 and 6 are also connected to an amplifier 8 whose input is connected to the signal output 7 of microphone 1.

At the signal output 7 two capacitors 2, 3 are connected for interference suppression, whose second electrodes are connected to ground 15 through conductor 5 on the one hand and to conductor 6 at microphone 1, respectively. The output of amplifier 8 feeds a receiver (loudspeaker) 9.

In another embodiment of the invention, as shown in Fig. 6, two capacitors 2, 3 are connected to the ground connection 15 through conductor 5 on the one hand, while the other electrode of capacitor 2 is connected to conductor 6 at microphone 1 and the second electrode of capacitor 3 is connected to the signal output 7 of the microphone.

As it can be seen from Figs. 2 and 3, microphone 1 has soldering pads 4 one of which is a ground connection 15 and the other one is connected via conductor 6 to the positive side of battery 10 and the third one is the signal output 7 of the microphone.

The two capacitors 2 and 3 in form of SMD-chip capacitors are arranged directly with their electrodes 2.1, 2.2, 3.1 and 3.2 at the soldering pads 4 of the microphone and soldered thereto.

Fig. 4 shows the interference sensitivity of a normal behind-the-ear hearing aid of the typ 145S without additional anti-interference devices. It shows that the permissible limit IRLL max + gain (input-referred interference level + gain), which is also depending on the gain of the hearing aid, is clearly exceeded with respect to the frequency range in question (840 - 900 MHz).

Fig. 5 shows in comparison the interference sensitivity of the same hearing aid with an HF-filter device according to the invention.

In the diagrams of Figs. 4 and 5 the left-side axis show the loudspeaker sound pressure La related to the threshold of audibility of 20 Pa. The right side axis of Fig. 5 shows the input-referred interference level IRIL related to the threshold of audibility of 20 Pa.

A comparison of the diagrams Fig. 4 and Fig. 5 shows that by incorporation of the capacitors 2 and 3 according to the invention into the same hearing aid the interference sensitivity for the same field strength (3V/m) has clearly dropped and the permissible limit IRIL + gain is no longer exceeded.

Claims

1. A hearing aid having an Electrete microphone with its output connected via an HF-filter device to an amplifier, said HF-filter device being operable in particular in a frequency range between about 900 - 1600 MHz,
characterized in
that the HF-filter device consists of two capacitors (2, 3) which are arranged between the signal output (7) of the microphone (1), the ground connection (15) and the power supply connection (6).

2. A hearing aid according to claim 1,
characterized in
that the capacitors (2, 3) are connected between the signal output (7) and the ground connection (15) or between signal output (7) and the power supply connection, respectively.

3. A hearing aid according to claim 1,
characterized in
that one side of each of the capacitors (2, 3) is connected to the ground connection (15), while the other electrode of one capacitor (3) is connected to signal output (7) of the microphone (1) and the other electrode of the other capacitor (2) is connected to power supply connection (6).

4. A hearing aid according to claim 1,
characterized in
that the capacitors (2, 3) are SMD-chip capacitors.

5. A hearing aid according to claim 1 or 2,
characterized in
that the capacitors (2, 3) are soldered directly to the solder pads (4) of the microphone (1).

6. A hearing aid according to claim 1 or 2,
characterized in
that the capacitors (2, 3) are mounted by lying flat on the microphone and connected to its soldering pads by wires with a maximum length of 5 mm.

7. A hearing aid according to claim 1,
characterized in
that the two capacitors (2, 3) are integrated into a ceramic substrate inside the housing of the microphone (1).

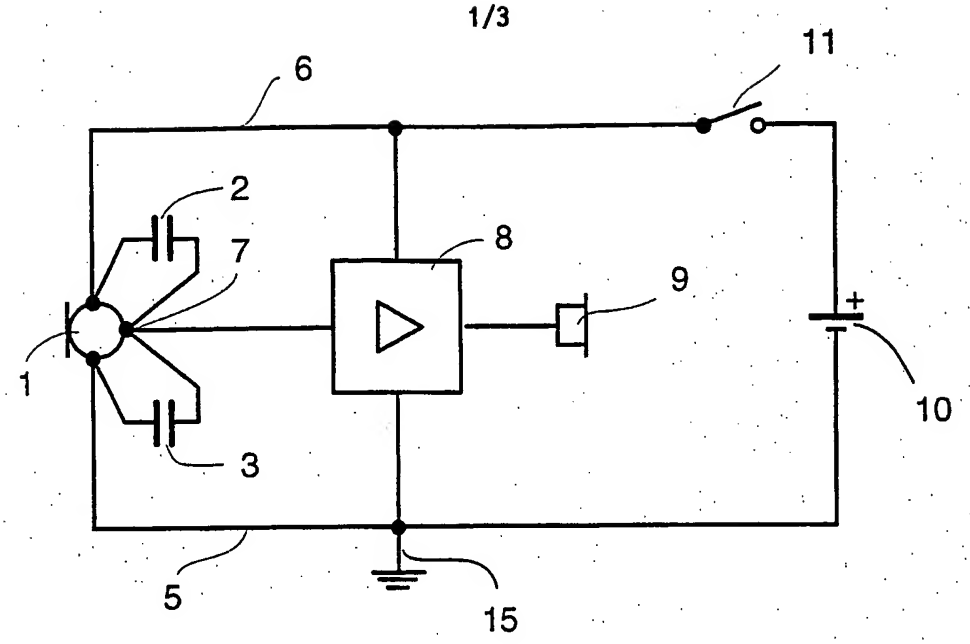


Fig. 1

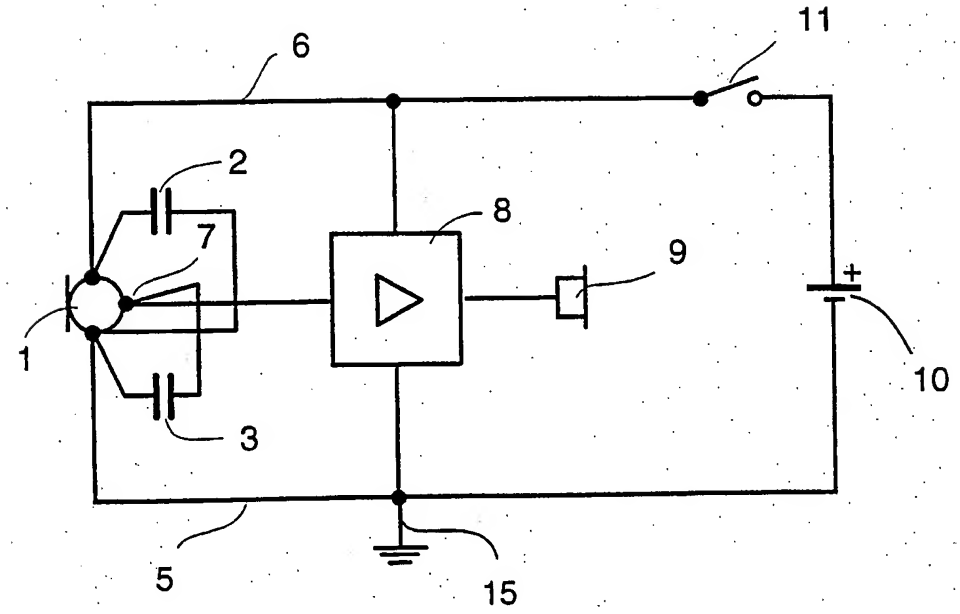


Fig. 6

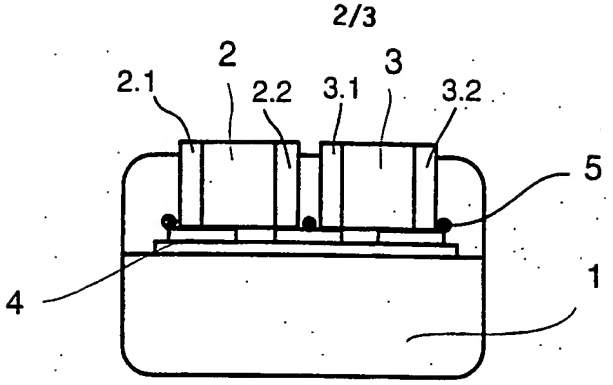


Fig. 3

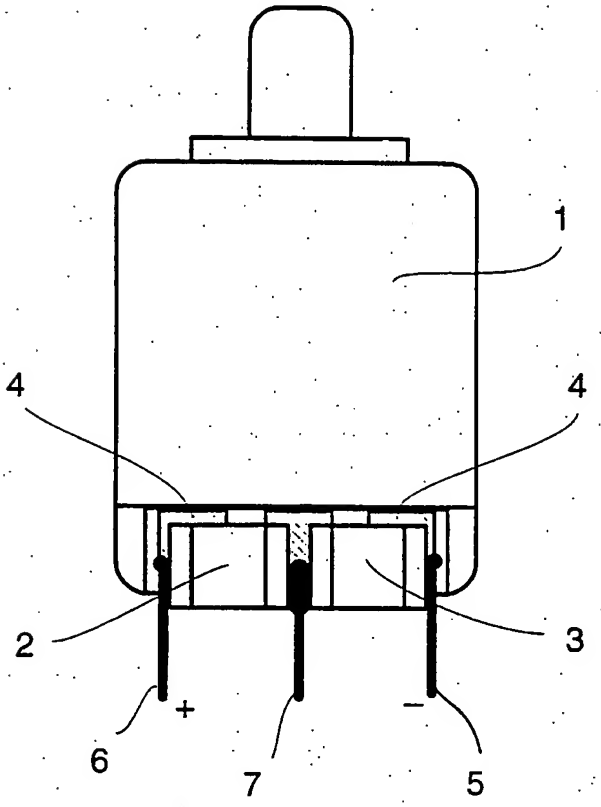
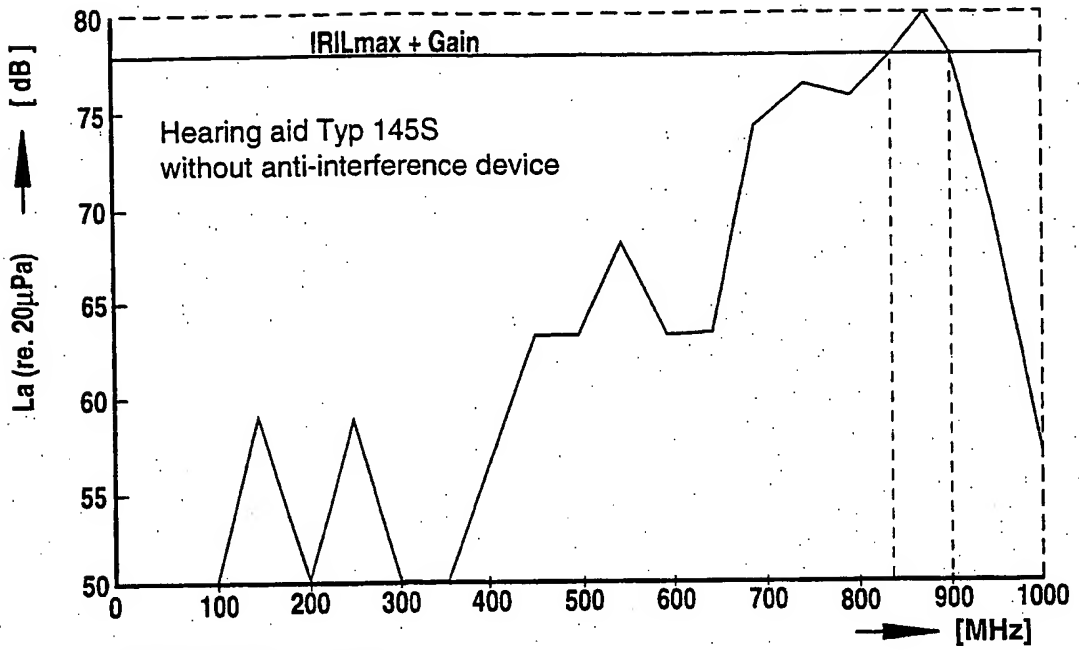


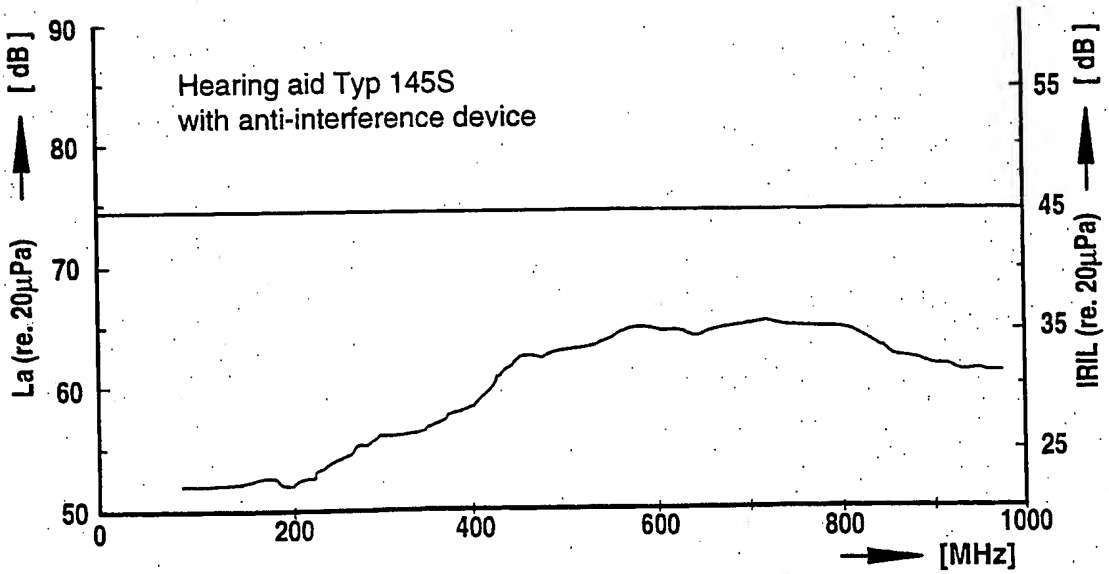
Fig. 2

Interference sensitivity



field strength = 3 V/m
f_m = 1 kHz
m = 0,8

Fig. 4



field strength = 3 V/m
f_m = 1 kHz
m = 0,8

Fig. 5

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 96/02114

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04R25/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04R H01G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	DE,A,43 43 703 (SIEMENS) 5 January 1995 see column 1, line 37-59 see column 2, line 5-25 see column 2, line 47 - column 3, line 55	1-3
A	GB,A,2 105 147 (ROBERT BOSCH) 16 March 1983 see page 1, line 5-48 see page 1, line 56-122	1-3,5,6
A	DE,A,38 21 592 (R.S.B.E.K.S.) 20 April 1989 see column 1, line 3 - column 2, line 56	1,4

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INTERNATIONAL SEARCH REPORT

...formation on patent family members

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